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Abstract

POTENTIALITIES OF PULSED REACTORS

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A pulsed reactor differs from the common type in that it operates in cycles, the cycle including the operation and cooling stages. Within certain limits, the higher the cooling time to operation time ratio (duty ratio) the cheaper is the realization of the desired neutrons flux. There are the following types of pulsed reactors: the pulsed type proper, the cycle pile, and the homogeneous reactor.

The difference between the two latter types is to a certain degree a conditional one - in the cycle pile the core moves along the reactor body, while in the homogeneous type the situation is reversed.

The pulsed reactor proper is advantageous in experiments including neutron sorting by the time of flight. In this case narrower but sufficiently frequent pulses are desirable. Such a reactor with a cooling system removing several megawatts of power and with pulse frequency of the order of 10^2 per second, have advantages over the stationary high neutron flux reactor since it uses tens of times less fuel than the latter and its heat transfer system is relatively cheap.

The cycle pile is preferable to the pulsed reactor when a strong integral flux is required along with high flux. Such is the case, for instance, in experiments on neutrino interaction with matter where the neutrino source is a neutron-activated isotope. A great integral flux

is necessary to obtain good statistics while a high duty ratio (with a given mean power) provides a favourable relation between the background and the effect.

In the magnitude of neutron fluxes obtainable, pulsed reactors proper are not superior to cycle piles or homogeneous reactors. In all cases the ultimate neutron density is approximately equal to energy, which can be imparted to a unit volume of a coolant ⁿ during one cycle of heating (ξN), divided by fission energy, E_f . To be more exact,

$$n_{\max} = (V_f - 1) \frac{\xi}{E_f} N,$$

where N is the number of atoms in ^aunit volume of the reactor. If there is no provision for active zone transition into a plasma state ($\xi \approx 0.3$), then

$$n_{\max} \approx 10^{14} \text{ cm}^{-3}.$$

Pulsed reactors with different fuel concentrations have (for a given ξN) different pulse durations and integral flux densities, however these quantities' ratio has the above limit.

This limit also holds for homogeneous reactors with one-way movement of the coolant, though at first glance limitless forcing is possible by accelerating the coolant speed. Actually, at speeds of the order of 10^2 m/sec the carrying away of neutrons by the coolant becomes serious. To maintain the reactor at critical it is necessary to increase the size of the core. To a certain limit the required height of the core increases ^oproportionally to the speed of the coolant, the heat release in a unit volume of the reactor tending to its final limit. The limit can be shifted, in principle, only by the use of a counter current of coolant streams. Thus to shift the limit by an order, streams of a cross section not exceeding a quarter of the reactor's cross section are required.

The paper discusses prospects for the construction of pulsed reactors which would open up new horizons for

study of neutrino interactions with nucleons and electrons.

Several possible versions of such reactors are discussed and compared, and neutron physics and engineering aspects of the problem studied.